27 February 1961

MEMORANDUM TO: Chief, TISD

FROM: [redacted]

SUBJECT: Memorandum of meeting, 14-15 February 1961

Attendees: [redacted]

PURPOSE OF THE MEETING

1. The purpose of the meeting was to discuss some of the technical problems relating to a Spatial frequency analysis of photography and review the ramifications concerning this approach.

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2. The major areas of discussion were:

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a. The present status of the [redacted] Image Enhancement Devi[redacted]STATINTL which utilizes Spatial frequency analysis as its working principle.

b. Possible future uses of this equipment by consideration of modifications and adaptations.

c. Possible use of discreet illumination wavebands as a means of increasing resolution in optical instruments used for viewing photography.

d. Use of matched filtering as a means of image accentuations.

e. Application of filters exhibiting a Gaussian function when introduced into an optical viewing train.

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CONTRACT WORK WITH [redacted]

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3. [redacted] gave a full account of his work under the phase of the contract at present in operation with [redacted] The Spatial frequen[redacted]STATINTL

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analyzer is in [redacted] and previous contract work modified it to the point where it had:

a. An entirely adequate light source. This is now a mercury arc with an intensity increase of 10 over the original HBO 200 mercury vapor source. The output is modified by an Interference Filter, and the coherent radiation peaks at 5461A.

b. A modified high/low passband filter system which is STATINTL almost entirely automatic in operation after selection by the operator.

STATINTL 4. However, based on [redacted] in-house research done by [redacted] and also work in the same field done by other researchers, the work being done at present relates to improving the filter plane. In general, this consists of introducing the filtering which is noted in "d" and "e" of paragraph 2 as having been discussed at this meeting.

5. The design and efficiency of the filter plane is probably the most important part of the device. Problems relating to illumination have been solved, and optical problems either in the 1:1 system as we now have, or in modifying the analyzer to a 10:1 system, are not too difficult to overcome. To materially aid our work in interpretation, the machine must first be made to pass the higher frequency signals of which the small imagery consists. It is theorized that this can be done by:

a. Matching the filter to the frequency signal.

b. Constructing a Gaussian type filter which will pass all frequency signals, attenuating the low frequency signal rather than effecting a sharp cut-off. This should maintain contrast in the filtered image.

There is no reason why this should not be successful in practice
STATINTL as well as theory, and [redacted] is now working on doing it.

OTHER USES OF THE EQUIPMENT

6. During the discussion it became obvious that the Spatial filtering device, with certain modifications, could also have a role which we have not so far recognized, namely to determine resolution.

It is also becoming increasingly obvious that the expression of resolution in terms of lines per mm, qualified as either high or low contrast, is insufficient for our purposes. We require a system by which we can:

a. Determine the smallest image which can be interpreted in any piece of photography.

b. Determine the minimum magnification necessary to exploit the image.

7. Whilst lines per mm indicate a certain quality, this quality does not consider problems of contrast. As a result image quality may be high in terms of lines per mm, but with all the information in the toe of the H & D curve.

[redacted]

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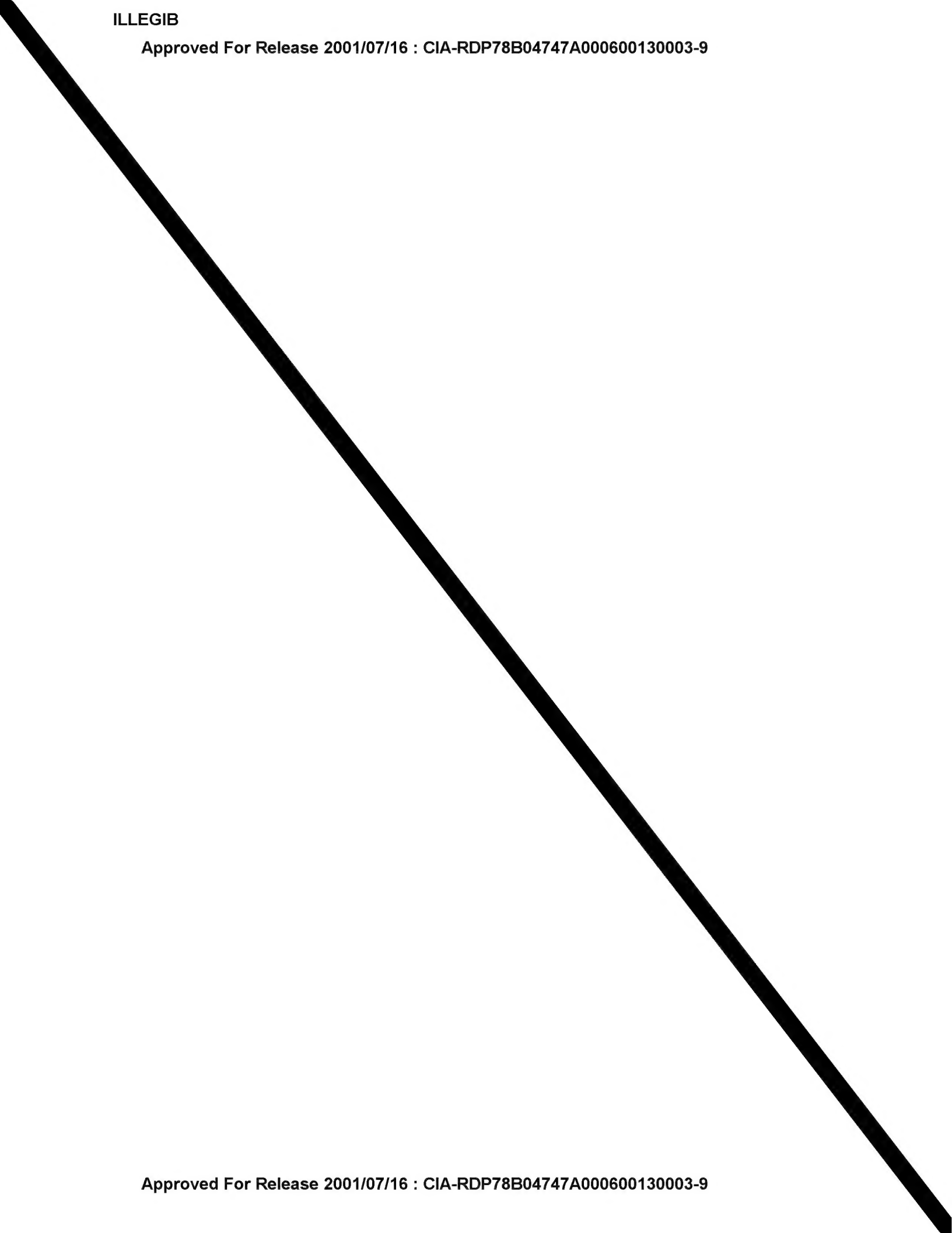
Figure I indicates such a situation whereby we have a nominally high resolution, say 100 l/mm, but with the mass of information in the region where microdensity variations between object and background are such that readout by normal means is impossible. The development of [redacted] equipment should help us to extract some of this "toe" information, but the figure of 100 l/mm tends to give a false impression of photographic quality.

8. Probably far better would be to consider expressing resolution in terms of sine wave response. [redacted] have demonstrated that in a practical photographic system neither high contrast nor low contrast resolving power correlate with picture definition. Contrast is of course important but is only one of several things affecting photographic definition in terms of an interpretable image. Of more importance to us when considering what can be interpreted in any photographic scene, is the spread function of the emulsion. Sine wave response and spread function represent much the same thing. Theoretically, we could obtain the information we require by using either an edge image to measure spread or a Sinusoidal pattern to measure sine wave response of the emulsion. As both the sine wave response of a lens and our emulsion can be determined, we can thus express the performance of a complete photographic system in such terms; this being the product of the individual response functions.

9. For an emulsion, the sine wave response would be expressed as the light incident on the emulsion rather than in terms of the density of the developed image. An experimental sine wave response determination system would be as in Figure 2.



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10. In general, this arrangement is also similar to part of the Spatial filter device and with modification could be so used. We also have the [redacted] projector, developed for the Group Viewing Contract, which could be adapted for such use without too much trouble.

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There has been some experimental work carried on in this field by different groups and a typical emulsion response result obtained by [redacted] is shown below in Figure 3.

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FIGURE 3.

11. I am not at present fully aware of all the ramifications, but am gathering all available information. I will report further in greater detail when I have more complete knowledge of the state of this approach.

12. By considering this carefully in conjunction with the Spatial filter device it would seem that we could have:

a. A machine to enhance an image.

b. A machine to determine resolution in terms of sine wave response. From this can be determined:

c. The quality of the image in terms of what and what cannot be resolved and interpreted.

d. Optimum magnification for exploitation.

13. The discussion as to what could be done with light for illuminating transparencies was not fully resolved. Talking in terms of a granular (average) size of 1-3 microns, it would appear that little can derive from waveband variations other than in a purely psychological sense. This still remains a point which will be pursued.

14. In general, the discussion was worthwhile, and it is suggested that these purely "blackboard" sessions, with contract working rather than executive level personnel, are extremely valuable.

[redacted] STATINTL